BIM METHODOLOGY. A TOOL FOR IMPROVING THE LEARNING OF CONSTRUCTION SYSTEMS

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Abstract

The construction sector is currently undergoing a process of change. For years, its methods of design and execution have been constant, without hardly modifications. Today, BIM technology (Building Information Modeling), has meant a conceptual revolution in how to manage the entire construction process. It is not a question of learning to use specific software; it is a change of roles, of working methodology. BIM technology seeks to centralize information in order to reduce duplicities leading to errors of execution and consequently to an unnecessary economic loss and an increase of the expected time frames. The solution of problems is now handled jointly by the different professionals who are part of the design and execution of a building: architects, calculation engineers, constructors and of course building engineers. There is no longer an individual work but a group work. Faced with this reality, professional change must be years before in the learning stage. In the Architectural Technology Degree there are several subjects where the application of BIM technology would be an incentive for the student. The student would be in contact with the latest software used in the construction sector, as well as BIM technology will provide him the understanding of the subject. As a particular case, the present paper focuses on the subject of "Fundamentals of Construction", compulsory subject of first year of the Architectural Technology Degree at the University of Alicante. This subject is a first contact of the student with the execution of structural elements, with materials such as reinforced concrete and / or steel. Traditionally, the process of teaching and learning in subjects related to building systems has been carried out following a theoretical and practical framework, where the student had to draw constructive solutions in two dimensions about foundations, slabs, flat covers... The first year student has specific deficiencies in this subject. Firstly, he does not have a previous knowledge about the subject, so even the vocabulary is a problem. Secondly, the top-floor or elevations views of constructive details in two dimensions do not give them the real vision of what is being proposed. In conclusion, it is intended to improve the learning of this subject with BIM technology. The introduction of basic BIM concepts that allow students to improve their attitude and aptitude to the subject is proposed for the next academic year. Three dimensions virtual model is done with BIM technology, from the beginning, modified and adapted with the inclusion of data, before and during the building construction. With specialist teachers in this technology, the Technical Architecture Degree provides the student not only the knowledge traditionally established, but a differentiating contribution among other universities, by introducing the latest technologies in teaching that will have its immediate reflection in their near professional activity.

Keywords: BIM, Building Information Modelling, architecture, constructive systems.

1 INTRODUCTION

1.1 The current situation at University. A new way of learning has born

The following paper presents a pourpose of a new learning methodology based on BIM (Building Information Modeling) applied to Architectural Technology Degree at the University of Alicante. The application of new technologies in the classroom results in more dynamic activities that improve team work and encourage greater student participation.

Currently, the teaching of subjects related to construction systems are based on a traditional learning model, Figure 1. Student performance is not very satisfactory and there is a lack of communication between teachers and students. There are lecture classes that follow a theoretical-practical ones. In these last classes, students have to draw the constructive details that have been explained before by the teacher. Students have to draw by hand, it is a technical draw. The structure is represented in several 2D details, sections and plants, and the different solutions depend on the material used: concrete (reinforced concrete structures) or steal (metal structure).

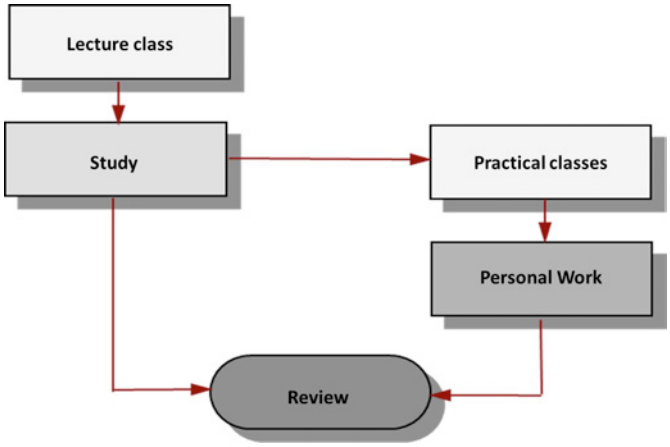

Figure 1. Current Teaching Organization.

Students are generally insecure of their knowledge and therefore are reluctant to participate in practical sessions. They do not attain the minimum levels of knowledge required to deal with a construction problem. They have troubles about the way they must draw the solutions, because they have not enough knowledge to imagine these structures in 3 dimensions.

In general, the theoretical knowledge acquired is insufficient and they are not able to understand all the information they receive. As a result, the study time at home are not used. Given this situation, the teacher must consider a new teaching strategy to regain student motivation and commitment to learning. The University studies must be adapted, so in that sense, we must teach the new technologies and software. CAD era born a few years ago but today we are in a new paradigm in architectural and construction thinking: The BIM era.

Students have a positive attitude towards the use of new technologies. Taking advantage of this situation, we will strengthen the implementation of dynamic strategies that encourage debate, reflection, teamwork, collaboration and decision-making. This change suppose a revolution in order to involve the students with the real working way the will be evolved as soon as they leave the University.

1.2 What is BIM (Building Information Modelling)?

Building Information Modeling is a new technology. It is not just a representation in three dimensions (3D). The BIM model has all the information of a building, in order to be known and shared by all agents involved in its conception: architects, building engineers, calculators, engineers....

It is an updated simulation of the reality that is intended to be built, in order to adapt the best execution decisions, from the design sketch of the building to its demolition, that is, throughout its entire life-cyrcle [1].

The most used software for the management of this virtual reality are the trademarks of Autodesk and Graphisoft / Nemetschek, namely Revit and Archicad. But they are not the only ones. There is a wide range of software in constant evolution related to architectural design, structural calculation, energy consumption, installations, planning, measurements and budgets, among others.

The BIM idea is the participation of the professionals involved in the project, focusing the design and the information in a single three-dimensional model that automatically generates the particular views: sections, plants ... and therefore the generation of all the defining planes of the project.

1.3 BIM methodology advantages

The traditional working method is outdated. The representation of the project with independent plans and memories implies duplication and / or discrepancies in the information. The plans are modified as the project evolves but there are not a global update of these changes in the whole project. There is a high error rate in the interpretation of which is the last update of the project. During the construction of the building this situation causes a lack of foresight, with the consequent increase of deadlines and costs.

In Spain, traditionally, the construction sector has not been characterized by its high level of industrialization. The automation of processes has not always been present. The project changes were solved many times “in situ”, where the best solution to be adopted was decided.

But in recent years the trend has been reversed. The current downturn in the Spanish construction sector has meant a change in the way of understanding the profession, in order to improve the process. This change is possible by the new concept of BIM. The advantages of the BIM methodology with regard to the traditional working method are obvious. The most important advantages are, Figure 2:

1 BIM platforms automatically update information that is edited anywhere in the model. This means that if an element is modified in a plant, it automatically changes in sections, elevations and 3D views, just as if you modify a feature in a list, it automatically changes throughout the project. Information is always consistent.

2 Every agent works on the same model. There is no possibility of loss information due to the lack of coordination between versions which are handle by the different professionals.

3 The project is developed in real time in a coordinated way in a collaborative environment, always under the client supervision.

4 BIM allows to have the information required when it is necessary, for instance design or technical information

5 It also possible to make in real time modifications that will automatically update all these parameters [2].

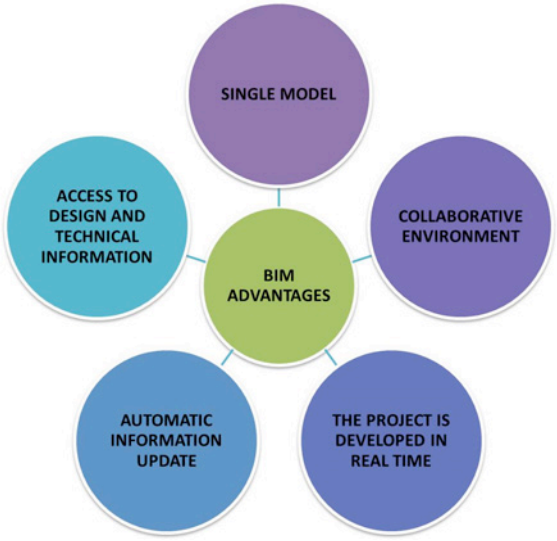

Figure 2. Advantages BIM Scheme.

1.4 Purpose

The goal to be achieved for the next academic year is to teach the student the BIM technology. It is intended as an integrated, multidisciplinary, coordinated and coherent work philosophy.

2 METHODOLOGY

2.1 Competence-based learning

The impact of BIM processes on the professional practice of architecture is evident. In this sense, University education has a strong responsibility. The incorporation into the European Higher Education Area (EHEA), also known as the Bologna Declaration, aims to facilitate the development of educational changes that keep teaching at the highest levels of teacher innovation [3].

A methodological change was established towards a model of teaching and learning based on the acquisition of competences. In the Architectural Technology Degree there are 10 General

Competences (G1 to G10), 37 Specific Competences (E1 to E37) and 3 Tranversal General Competences (G11 to G13). The items below could be improved with BIM technology, Figure 3.

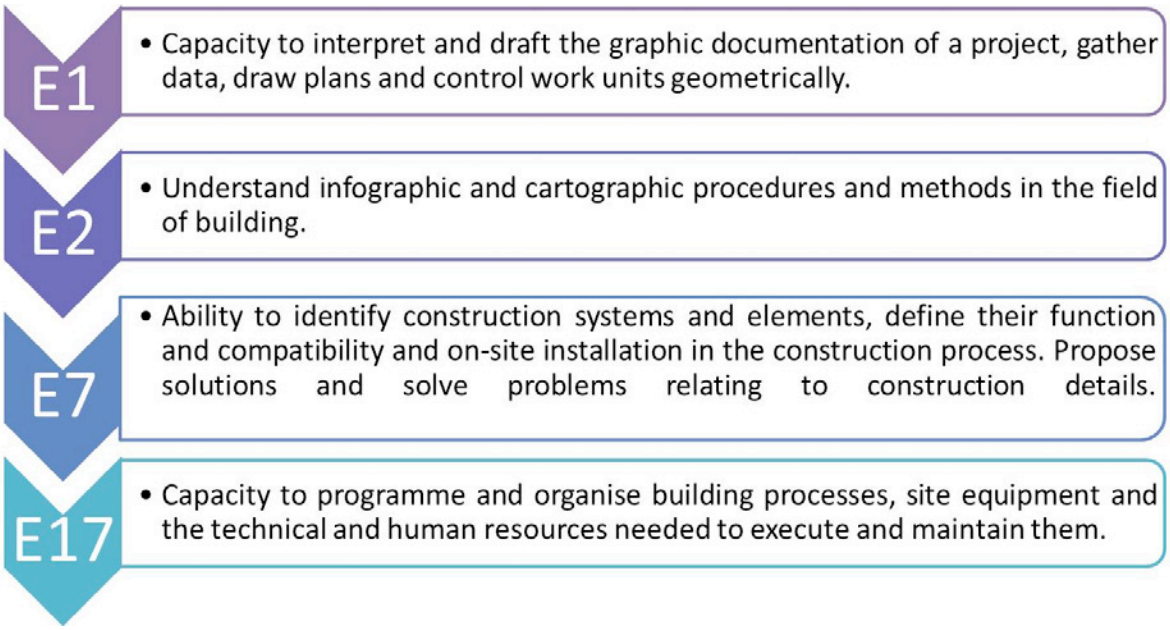

Figure 3. Specific competences that could be improved with BIM technology.

The ultimate goal to achieve with teaching in the Degree would be:

> *"Apply the knowledge, capabilities and skills acquired, putting students in touch with business and professional reality, completing and complementing their theoretical education with practical experience (E37)".*

Thus, the teaching of the BIM methodology is justified.

2.2 BIM. A tool to teach constructive elements

Traditionally, the process of teaching and learning in subjects related to building systems has been carried out following a theoretical and practical framework. This teaching methodology is based on a traditional learning model, with theoretical and practical classes, where tasks related to the theoretical contents are solved.

Currently, the teaching of the subject "Fundamentals of Construction" is based on a traditional learning model. This is a compulsory subject of first year Degree. There are sixty hours of face-to-face classes that follow a theoretical-practical model with conventional evaluation tests and student performance is not very satisfactory. Moreover, there is a lack of communication between teachers and students.

There are lecture classes where the teacher explains the constructive process. In the practical sessions, the students have to draw the details of real situations during the construction of a building: details of foundations, structure, façades, roofs or stairs, among others…, Figure 4.

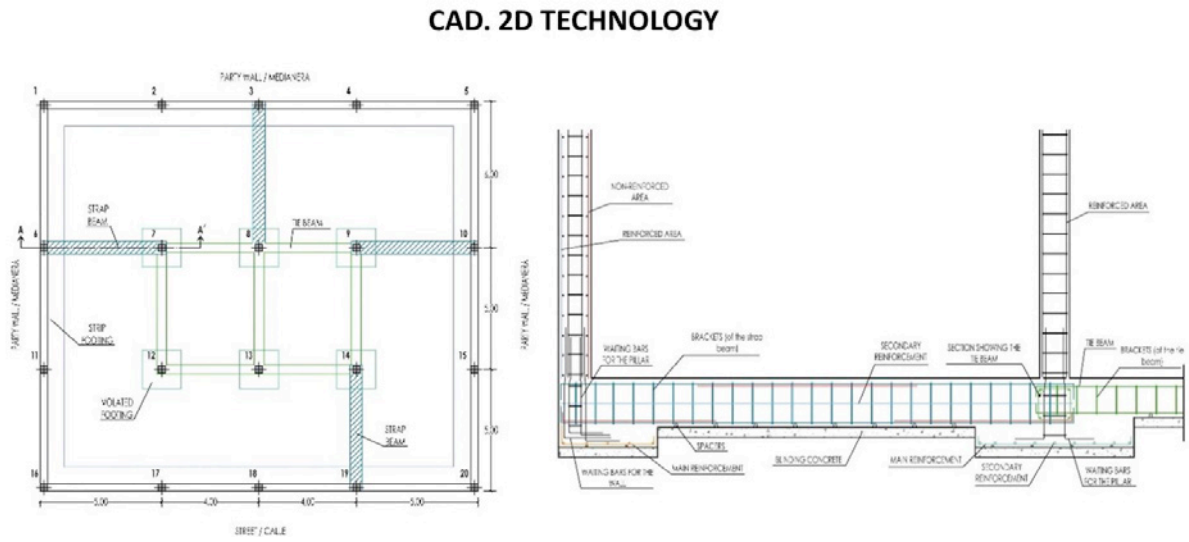

Figure 4. 2D Representation. Foundation details made by students in the actual practical classes.

Teaching methods need to be changed and motivation must exist from the teaching profession to implement the necessary changes. It is necessary to create a better learning environment, and as a result, the student will participate and finally will understand the module's contents.

Students have a positive attitude towards the use of new technologies. Taking advantage of this situation, we will strengthen the implementation of dynamic strategies that encourage debate, reflection, teamwork, collaboration and decision-making. The teacher must consider a new teaching strategy to regain student motivation and commitment to learning. Given this situation, it is proposed as a new objective in this subject to provide an adequate European profile training with the last construction sector technologies. It is necessary to teach in the knowledge and management of new technologies and methodologies that improve the building quality [4].

This learning methodology motivates students to improve their academic performance and consequently their results. Dynamic classes are more attractive to students and therefore, they are able to achieve their desired goals and, consequently, effective learning takes place.

In addition, there is an atmosphere of dialogue that provides individual and collective development. Many teachers have studied and applied new didactic and methodological approaches to the teaching of diverse disciplines and devised a multidisciplinary method of dealing with problems relating to student learning and motivation [5].

BIM discipline is eminently practical, with a double aspect. Firstly, the learning of the interface program, how to use it and how it works, which are the basic concepts we must understand, and secondly, the coherent application of constructive representations, which requires the theoretical knowledge of the subject.

It is necessary to approach a combination of methodologies. Lecture class should not be eliminated because the student demands it and it is needed as a formation training, especially in subjects as specific as "Fundamentals of Construction", so students have a homogeneous level of knowledge.

But it is necessary to guarantee the assimilation of concepts and the acquisition of the skills that are intended in the objectives of the subject, by the use of new technologies, in order to increase the level of participation of the students. For this reason, BIM technology would be a fantastic resource of learning [6], Figure 5.

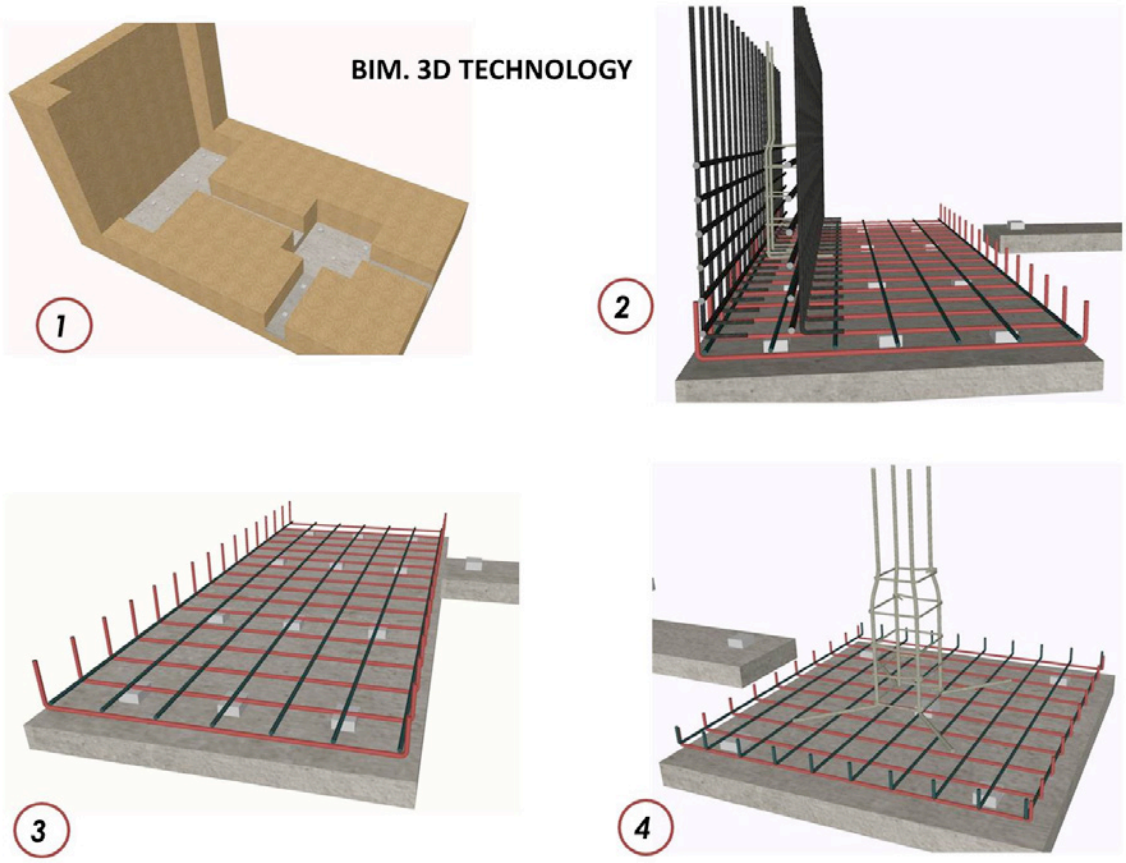

Figure 5. 3D Representation Foundation Details.

3 RESULTS

3.1 Planned teaching experiences

The new methodology explained must be applicated as soon as possible, in the first course of the Degree. The subject "Fundamentals of Construction" will be one of the first to adapt the existing paradigm for the next academic year.

A double objective is achieved. Adapt the University studies to the new technologies as a first step in the students professional future and improve the student's motivation, participation and learning, because it is prove that only with traditional teaching methods they do not obtain good academic results. The practical exercises will be developed with the BIM methodology, with a real case of a simple construction project. It is proposed in a workshop, where students work by groups and resolve the same statement. Collaborative work is encouraged as a prior experience before their professional future.

The teacher will dedicate part of the hours allocated for this workshop to explain REVIT interface, the basic concepts in order to make possible the modeling of the main constructive elements. Became an expert is a hard work with this kind of software. A lot of hours must be spent to understand every way to draw what you want. The student must complete his training with the available technological resources (self learning, tutorials, videos shared….). As a result, hours allocated to study time at home can not be lost. Finally, students will have to present the virtual model and be able to draw the main plans of the project: plants, sections, and of course simple constructive details.

There are a lot of future actions related with BIM. This must be only the beginning. Bim methodology must be adapted. Once BIM knowledge is consolidated in the modeling, the next step will be the adaptation of this methodology in all the subjects of the future courses of the Degree where BIM will be necessary: calculation of structures, design of installations, energy qualifications, measurements and budgets, etc.

All this, following the criteria established by the constructions standars, both in Spain and in Europe. The knowledge and competence of these new non-traditional didactic approaches are giving rise to new professional profiles in our sector.

4 CONCLUSIONS

BIM technology is not the future, it is the present. University studies are aimed to training the best professionals in each sector. For years, in architecture and construction, teaching has not undergone major conceptual changes, perhaps only adaptation to the new standards of obligatory compliance. The profession has undergone major changes neither. The initial approach to the projects always offered improvised modifications that were solved “in situ”.

Today the situation is very different. CAD technology has given way to BIM technology. There is no longer a unique graphic representation. Today there is an updated virtual model in real time. This pragmatic change can not be ignored and since the previous years of formation, the student must become familiar with the new understanding of the profession.

We propose the application of BIM technology in a subject of First year of the Architectural Technology Degree with a marked constructive character, as a pilot experience, with the objective of progressing in its implementation in the higher courses.

As a final conclusion, it should be noted that the effort should not only be made from students. Professors have to adapt and regenerate in the new demands of the sector.

Every effort is rewarded, and in this sense, the Architectural Technology Degree at the University of Alicante would become a benchmark of innovative university education at the national level.

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